Z+ Series

Programmable DC Power Supplies
200W/400W/600W/800W in 2U
Built-in USB, RS-232 & RS-485 Interface

User Manual

Optional Interface:
IEEE488.2 SCPI (GPIB) Multi-Drop

TDK·Lambda

USER MANUAL FOR

IEEE Programming Interface

Z+ POWER SUPPLIES

Manual Supplement

Refer to the Z+ Technical Manual for information on installing the power supply, safety requirements, specifications, operating the front panel, using the serial RS-232/485, USB programming and the analog programming.

IA710-04-03A

Table of Contents

INTRODUCTION

The internal factory installed General Purpose Interface Bus (GPIB) allows operation of the Z^+ Power Supply from a computer via IEEE-488.
The interface allows the user complete remote control of the Power Supply, including output voltage and current setting and monitoring, protection setting, trigger, waveform list operation, Power Supply status and SRQ reporting.
Communication over the GPIB interface meets IEEE 488.2 standards for Programmable Instrumentation (SCPI) compliant.

SCOPE OF MANUAL

This manual contains the information needed to operate the optional embedded IEEE(GPIB) Interface used in the Power Supply. It includes the following:

- A general description of the GPIB.
- Connection.
- Configuration.
- Listing and description of SCPI command.
- Communication Example.

CHAPTER 1: THE IEEE-488.2 INTERFACE

The IEEE-488 digital programming interface (also called the GPIB interface) is a popular way to connect instruments to a computer. It uses a specialized 24-pin cable with connectors that allow cables to be 'stacked' together. There are eight data wires; eight control wires and eight ground wires. If the system runs from a personal computer, there are numerous vendors of IEEE controller cards and software.
The IEEE-488 standard has gone through several upgrades. The IEEE-488.1 focused on the handshaking of the eight control lines. The IEEE-488.2 added status registers inside each instrument and it added common commands to make programming groups of instruments easier. The latest specification, SCPI, adds guidelines for the command syntax so one vendor's Power Supply will use the same commands as another's. The Interface follows all of these standards.
Because many instruments may be connected and independently controlled by a single IEEE controller, each instrument must have a unique address. The IEEE controller automatically sets its address equal to the Power Supply address.
For complete and specific information, refer to the following documents: *ANSI/IEEE Std 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation* and *ANSI/IEEE Std 488.2-1987 IEEE Standard Codes, Formats, Protocols and Common Commands.*

CHAPTER 2: CONNECTION

This section provides information on variable IEEE (GPIB) connection modes, communication cables and selecting communication parameters for operation via IEEE (GPIB) interface.
It is possible connect to IEEE (GPIB) interface in two ways.

2.1 Point to Point

One IEEE Interface can control only one Z+ Power Supply. Refer to Fig.2-1. Each Power Supply must be configured for IEEE communication interface. Each unit must have a unique address, ranging from 01 to 31. Baud rate and address are automatically fixed to "57600" and "SCPI ".

2.2 Multi Drop

One IEEE Interface can control more than one Z+ Power Supply. A maximum of 30 Z+ units can be connected via RS485 interface to a Power Supply with the installed IEEE option. Refer to Fig.2-2.The Power Supply connected to a PC via the GPIB cable must be configured for an IEEE communication interface, the other must be configured for a RS485 interface. Each unit must have a unique address, ranging from 01 to 31. IEEE module gets the address of the unit into which it is installed. For RS485 interface set Baud rate at "57600" bps and Communication Language to "SCPI ".

2.2.1 Selecting One Power Supply in a Multi Drop Chain

All the SCPI commands may be sent to any one of the Power Supplies in an RS-485 chain by first sending the `INST:nSEL` address command. All commands and queries will then apply only to the selected Power Supply, until a new `INST:nSEL` is sent.
At power-up, the IEEE master Power Supply is automatically the one selected.
After sending `INST:nSEL`, it is recommended that you verify the command by sending `INST:nSEL?`, otherwise the following commands may be sent to the wrong Power Supply.

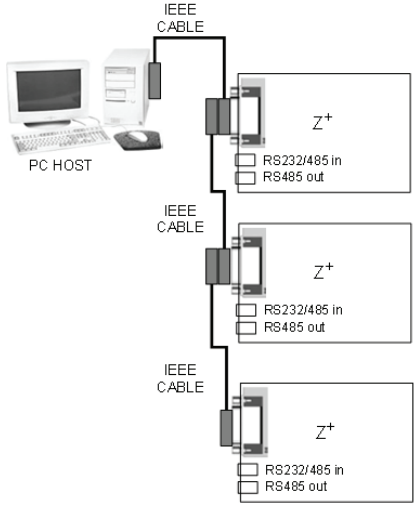

Fig.2-1: Point To Point Connection

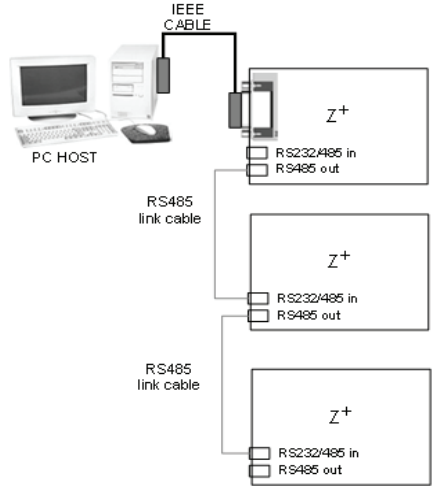

Fig.2-2: Multi Drop Connection

2.3 Communication Cables

- GPIB cable - Use standard IEEE-488, 26 AWG GPIB cable up to 3 meters in length.
- RS485 link cable - Use serial link cable with RJ-45 shielded connectors (P/N: GEN/RJ45). Refer to Z+ Series User Manual Fig.7-8.

CHAPTER 3: CONFIGURATION

3.1 Configuration the IEEE Controller

A typical IEEE controller is a personal computer with an IEEE interface card. Each card vendor supplies its own configuration instructions and interface software.
Each time the software is executed, the controller is configured as follows:

- Controller Address = Power Supply address.
- Serial bus Baud Rate = 57600
- SCPI protocol.
- EOI Flag = TRUE. The "End or Identify" is a control line in the IEEE cable that is initiated when the last character of a message string is sent. It is not supported by this interface.
- EOS Flag = FALSE: The "End of String", used in some instruments to indicate the last character of a message. It is required for this interface.

Fig.3-1: Front Panel

Fig.3-2: Rear Panel

1. AC ON/OFF Switch
2. REM LED/Buttom
3. Voltage Encoder
4. Voltage Display
5. Current Encoder
6. Current Display
7. RS-232/RS-485 INPUT Remote Serial Programming
8. RS-485 OUTPUT to other Z^+ Power Supplies

3.2 Configuration the Power Supply

Refer to Fig.3-1.

3.2.1 To Select the Communication Interface

1. Press REM button. The LED is illuminated. "InTF" appears on Voltage display.
2. Press Voltage Encoder. Existing communication mode appears on Current display.
3. Turn Current Encoder until desired message appears; "IEEE" (for unit with IEEE option) or "485".
4. To select desired parameter press Current encoder.

3.2.2 To Select the Address

1. Press REM button. The LED is illuminated. "Adr" appears on Current display.
2. Press Current Encoder. Existing address mode appears on Current display.
3. Turn Current Encoder until desired address appears.
4. To select desired address press Current encoder.

3.2.3 To Select the Baud Rate 57600. (485 Interface only)

1. Press REM button. The LED is illuminated. "InTF" appears on Voltage display.
2. Turn Voltage Encoder until "bAUd" message appears on Current display
3. Press Current Encoder. Existing Baud Rate appears on Current display.
4. Turn Current Encoder until "57600" appears.
5. To select desired Baud Rate press Current encoder.

3.2.4 To Select the Communication Language SCPI. (485 interface only)

1. Press REM button. The LED is illuminated. "InTF" appears on Voltage display.
2. Turn Voltage Encoder until "LAnG" message appears on Current display
3. Press Current Encoder. Existing Language appears on Current display.
4. Turn Current Encoder until "SCPI " appears.
5. To select desired Language press Current encoder.

For more information refer to section 4 of Z^+ series User Manual

CHAPTER 4: PROGRAMMING COMMANDS

Communication over the GPIB interface meets IEEE 488.2 standards and is Standard Commands for Programmable Instrumentation (SCPI) compliant.

4.1 SCPI Protocol

Refer to section 7.10 of Z+ series User Manual

4.2 SCPI Common Commands

Common commands are used to control instrument status registers, status reporting, synchronization, data storage, and other common functions.

***CLS**	Clear Status command. Clears the entire status structure.
***ESE <NR1>**	Standard Event Status Enable command.
***ESR?**	Standard Event Status Register query.
***IDN?**	Identification query.
***OPC**	Operation Complete command.
***OPC?**	Operation Complete query.
***OPT?**	Returns a string identifying internal options.
***PSC <bool>**	Power-On Status Clear (PSC).
***RCL <NR1>**	Restores the Power Supply to a state previously stored in memory.
***RST**	Resets the Power Supply to a defined state.
***SAV <NR1>**	The SAV command saves all applied configuration setting.
***SRE <NR1>**	Service Request Enable command.
***STB?**	Status Byte query. Returns the contents of the Status Byte Register.
***TRG**	Command starts the waveform when the trigger source is set to BUS.
ABORt	Resets the trigger system and places the Power Supply in an IDLE state.

For more information refer to section 7.11 of Z+ series User Manual.

4.3 SCPI Subsystem Commands

Subsystem commands control all Z+ functions. For a full command description refer to section 7.12 in Z+ series User Manual. Short list of Z+ series commands:

OUTPut		
	[:STATe] <bool>	Enable/Disable output
	[:STATe]?	Enable/Disable output query
	:PON	
	[:STATe] <bool>	Set power-on state in Safe or Auto start
	[:STATe]?	Power-on state in Safe or Auto start query
	:PROTection	
	:CLEar	Reset latched protection
	:FOLDback	
	[:MODE] <CRD>	Protection at transition CC<->CV modes
	[:MODE]?	Protection at transition CC<->CV modes query
	:DELay <NR3>	Delay before protection activated
	:DELay?	Delay before protection activated query
	:ILC	
	:MODE <CRD>	Set remote inhibit input (ENAble|DISable)
	:MODE?	Set remote inhibit input query
	:TTLTrg	
	:MODE <CRD>	Set or disable Function Strobe Mode
	:MODE?	Function Strobe Mode query
	:RELay	
	[:STATe] <bool>	Set programming pin status
	[:STATe]?	Programming pin status query
	:MODE?	Replay operation mode CV/CC/OFF
INSTrument		
	:COUPle <CRD>	Couple for all Z+ power supplies
	:NSELect <NR1>	Select the Power Supply to remote operation
	:NSELect?	Selected Power Supply
VOLTage		
	[:LEVel]	
	[:IMMediate]	
	[:AMPLitude] <NR3>	Set output voltage
	[:AMPLitude]?	Set output voltage query
	:TRIGger <NR3>	Set current value for trigger pending
	:TRIGger?	Set current value for trigger pending query

:PROTection		
	:LEVel <NR3>	Set OVP value
	:LEVel?	Set OVP value query
	: LOW	
	:STATe <CRD>	Set UVP or UVL mode
	:STATe?	Set UVP or UVL mode query
	:[LEVel] <NR3>	Set UVP|UVL value
	:[LEVel]?	Set UVP|UVL value
	:CLEar	
:MODE <CRD>		Set arbitrary trigger control mode
:MODE?		Set arbitrary trigger control mode query

CURRent		
[:LEVel]		
	[:IMMediate]	
	[:AMPLitude] <NR3>	Set output Current
	[:AMPLitude]?	Set output Current query
	:TRIGger <NR3>	Set current value for trigger pending
	:TRIGger?	Set current value for trigger pending query
:MODE <CRD>		Select arbitrary trigger control mode
:MODE?		Select arbitrary trigger control mode query

MEASure	
:CURRent[:DC]?	Reads the measured output current.
:VOLTage[:DC]?	Reads the measured output voltage.
:POWer[:DC]?	Reads the measured output power.

DISPlay	
[:WINDow]:STAT <bool>	Display ON/OFF
[:WINDow]:FLASh <bool>	Display Flash ON/OFF

INITate	
[:IMMediate]	Enables the trigger subsystem.
:CONTinuous <bool>	Trigger system is continuously enabled/disabled
:CONTinuous?	Trigger system is continuously enabled/disabled

LIST

:COUN <NR3>	Set the number of times the list is executed before it is completed.
:COUN?	Set the number of times the list is executed query
:CURR <NR3>	Specifies the output current points in a list.
:CURR?	Specifies the output current points in a list query.
:DWEL <NR3>	Specifies the time interval that each point of a list is to remain in effect.
:DWEL?	Specifies the time interval that each point of a list is to remain query.
:LOAD <NR1>	Loads from memory LIST type.
:STEP <CRD>	Determines if a trigger causes to next point or through all points.
:STEP?	Determines if a trigger causes to next point or through all points query.
:STORe <NR1>	Saves data under specified numbers <1..4> of the last LIST typed
:VOLT <NR3>	Specifies the output voltage points in a list.
:VOLT ?	Specifies the output voltage points in a list query.

STATus

:OPERation	Returns the value of the event register
[:EVENt]	Returns the value of the condition register
:CONDition?	Set current value for trigger pending
:ENABle <NR1>	Enables specific bits in the Event register
:ENABle?	Enables specific bits in the Event register query
:QUEStionable	
[:EVENt]	Returns the value of the event register
:CONDition?	Returns the value of the condition register
:ENABle <NR1>	Enable specific bits in the Event register
:ENABle?	Enables specific bits in the Event register query

SYSTem

:ERRor:ENABle	Enable Error Message
:ERRor?	Read system error. Refer to table 9-6 of Z^+ series User Manual
:LANGuage	Switch to GEN Language
:REMote	
[:STATe] <CDR>	Set program communication mode
[:STATe]?	Set program communication mode query
:VERSion?	Z^+ Main software revision
:DATE?	Calibration date
:PON:TIME?	Operation time from first power on applied

TRIGger		
	[:START]	Run trigger
	:DELay <NR3>	Set trigger delay
	:DELay?	Set trigger delay query
	:SOURce <CRD>	Set trigger source
	:SOURce ?	Set trigger source query
WAVE		
	:COUN <NR1>	Set the number of times that waveform is executed before it is completed.
	:COUN?	Set the number of times that waveform is executed before it is completed query.
	:CURR <NR1>	This command specifies the output current points in a list.
	:CURR?	This command specifies the output current points in a list query.
	:LOAD <NR1>	Loads from memory WAVE type.
	:STEP <CRD>	Determines if a trigger causes to next point or through all points.
	:STEP?	Determines if a trigger causes to next point or through all points.
	:STORe <NR1>	Saves data under specified numbers <1..4> of the last WAVE typed
	:TIME <NR1>	Set the slope time of the waveform.
	:TIME?	Set the slope time of the waveform query.
	:VOLT <NR3>	Specifies the output voltage points in a waveform list.
	:VOLT?	Specifies the output voltage points in a waveform list query.
GLOBal		
	:OUTPut	
	[:STATe] <bool>	Set all Power Supply Output On /OFF
	:VOLTage	
	[:AMPLitude] <NR3>	Set all Power Supply output voltage
	:CURRent	
	[:AMPLitude] <NR3>	Set all Power Supply output current
	:*SAV <NR1>	Same as *SAV <NR1>
	:*RCL <NR1>	Same as *RCL <NR1>
	:*RST	Same as *RST

4.4 Register Structure

Refer to Fig.3-1.
Refer to section 9 of Z^+ series User Manual.

4.5 The Summary Registers

The INSTRUMENT SUMMARY EVENT REGISTER, ISUM1 through ISUM3 (Refer to Fig.3-2), will record the address of the supply causing an SRQ. These are 'EVENT' registers and the bits will remain set until read by the `STAT:QUES:INST:ISUMn` command. (Refer to Table 4-1)

Command	Description
STATus:QUEStionable :INSTrument:ISUMmary1?	Reads the source of the SRQ in Logical Z^+ Supplies 0 through 13
STATus:QUEStionable :INSTrument:ISUMmary2?	Reads the source of the SRQ in Logical Z^+ Supplies 14 through 27
STATus:QUEStionable :INSTrument:ISUMmary3?	Reads the source of the SRQ in Logical Z^+ Supplies 28 through 30
STATus:QUEStionable :INSTrument:ISUMmary1:ENABle xx	Enable supplies to cause IEEE SRQ in Logical Z^+ Supplies 0 through 13
STATus:QUEStionable :INSTrument:ISUMmary2:ENABle xx	Enable supplies to cause IEEE SRQ in Logical Z^+ Supplies 14 through 27
STATus:QUEStionable :INSTrument:ISUMmary3:ENABle xx	Enable supplies to cause IEEE SRQ in Logical Z^+ Supplies 28 through 30
STATus:QUEStionable :INSTrument:ISUMmary1:ENABle?	Read which supplies can cause IEEE SRQ in Logical Z^+ Supplies 0 through 13
STATus:QUEStionable :INSTrument:ISUMmary2:ENABle?	Read which supplies can cause IEEE SRQ in Logical Z^+ Supplies 14 through 27
STATus:QUEStionable :INSTrument:ISUMmary3:ENABle?	Read which supplies can cause IEEE SRQ in Logical Z^+ Supplies 28 through 30

Table 4-1: ISUM commands

4.6 Output Queue

Refer to section 9.6.16 of Z^+ series User Manual.

4.7 Error Messages

Refer to section 9.6.17 of Z^+ series User Manual.

4.8 Execution Time

Command execution time except for *CLS (150mS) is less than 15 milliseconds.

INST:NSEL 06	11 millisecond
OUTP:STAT ON	12 millisecond
:VOLT 15	10 millisecond
WAVE:TIME 1,1,1,1,1,1,1,1,1,1,1,1	14 millisecond

Query execution time is between 20-50 milliseconds. Response is dependent upon string length.

WAVE:VOLT?	45 millisecond
SYST:ERR?	22 millisecond
*IDN?	38 millisecond
INST:NSEL?	20 millisecond

It is required that the user adds a delay after a command before sending any further messages. (Refer to Table 4-2)

ADDRESSED COMMAND/QUERY	10 milliseconds
GLOBAL COMMAND	20 milliseconds

Table 4-2: Addition of Delay

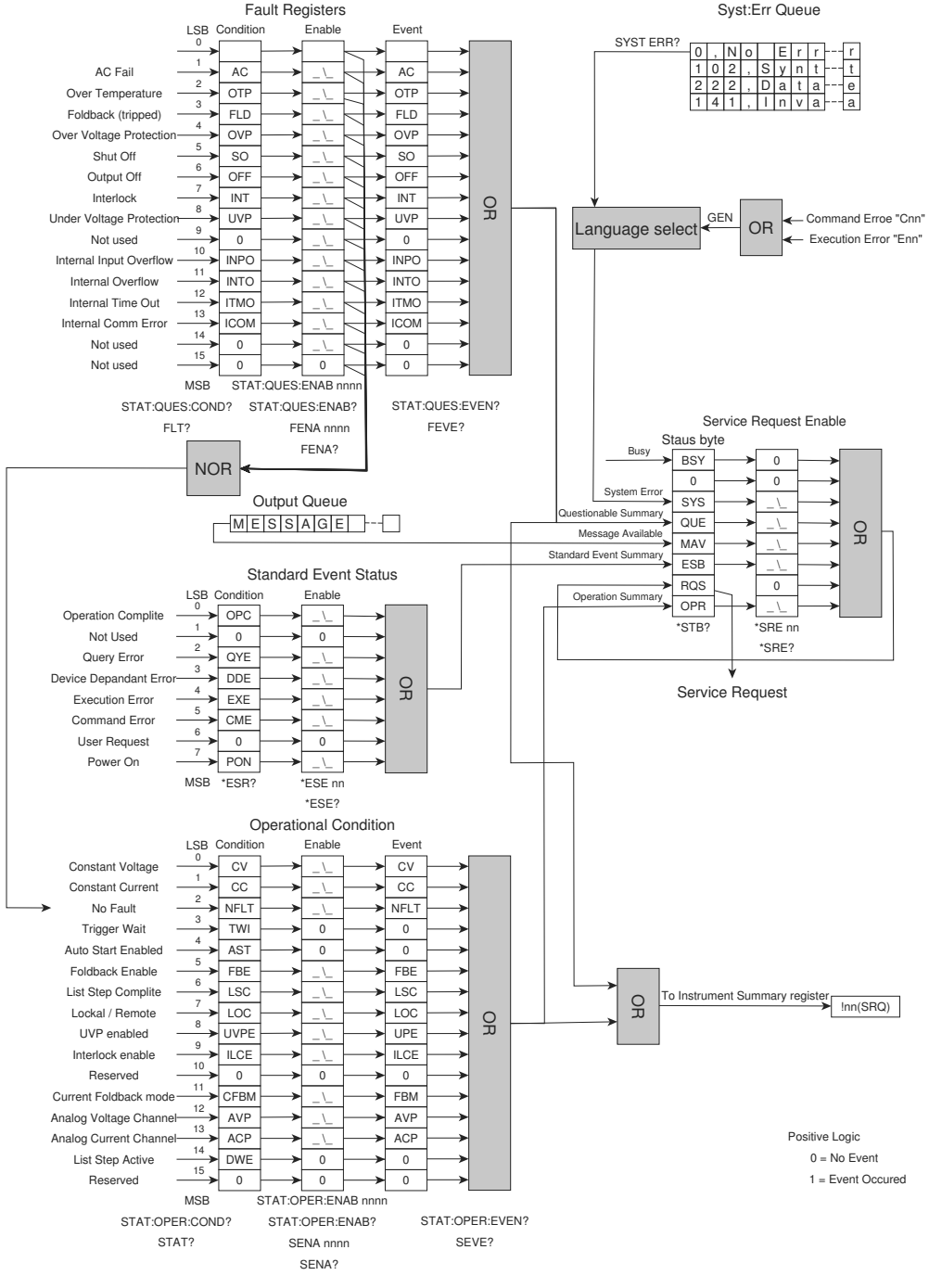

Fig.4-1: Status Register and SRQ Tree

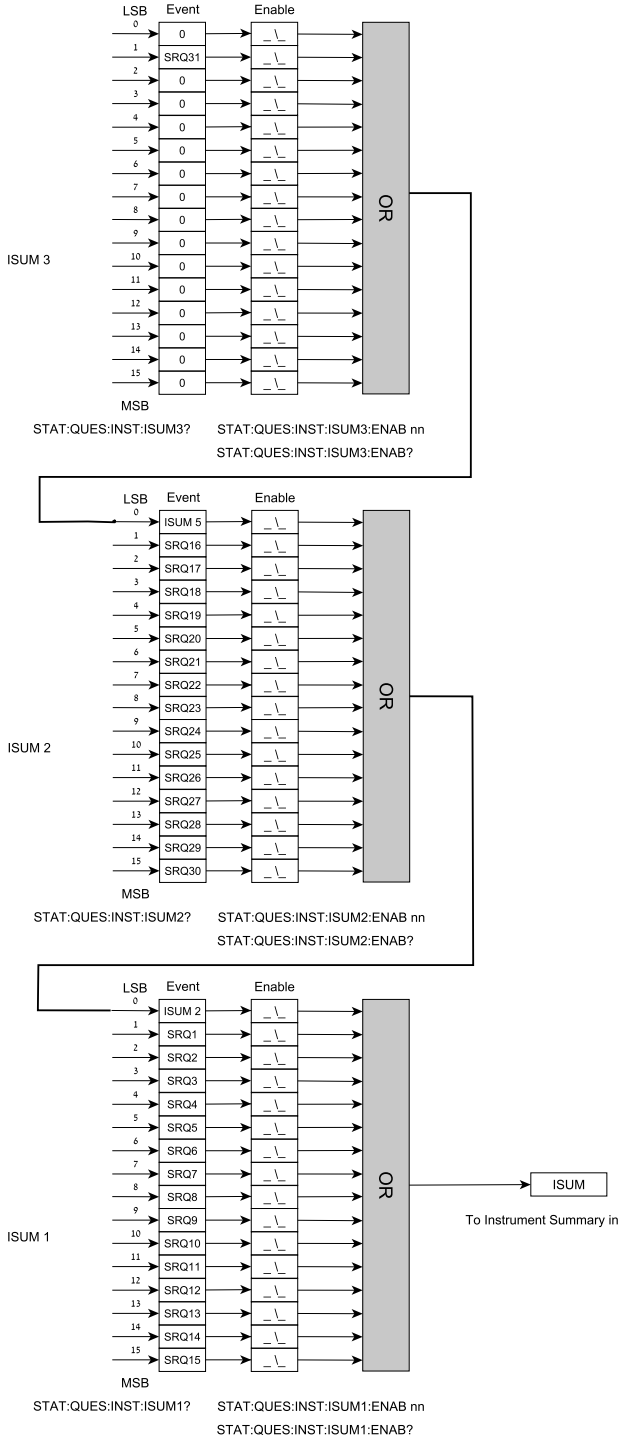

Fig.4-2: Instrument Summary Register Tree for Multi Drop Mode

CHAPTER 5: COMMUNICATION EXAMPLE

This section provides an example the National Instruments™ MAX program to communicate with the Z+.

1. Run National Instruments™ MAX (Measurement & Automation Explorer) program 

2. Select “Devices and Interfaces” -> “GPIB0” press Scan for Instruments. Refer to Fig.4-1

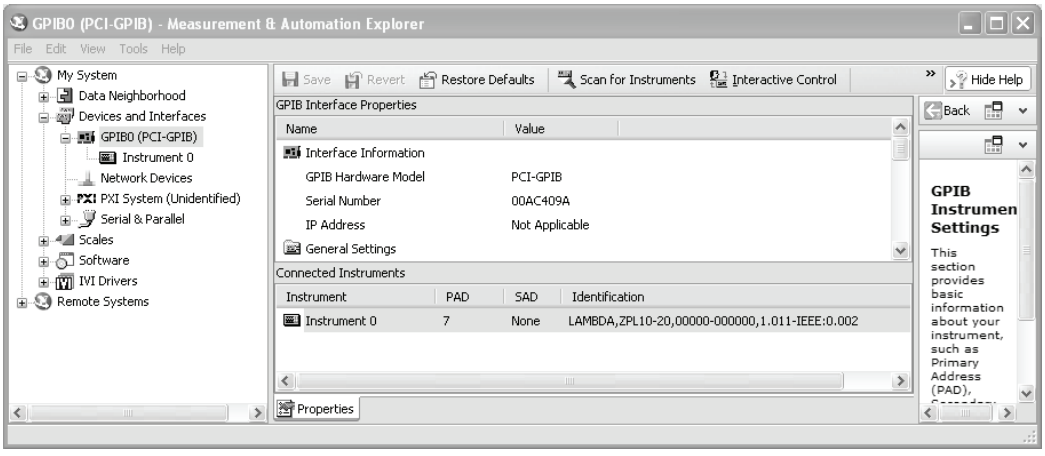

Fig.5-1: Scanning for Instrument

3. In the right window, click on Instrument0 and review the device properties. Refer to Fig.4-2

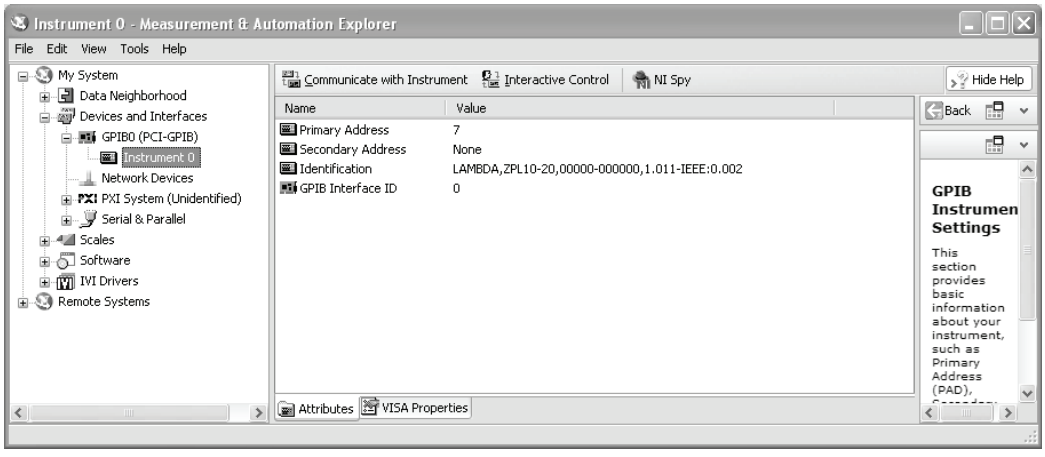

Fig.5-2: Instrument Properties

4. Click Communicate with Instrument in the GPIB Explorer toolbar. NI-488.2 Communicator appears. Refer to Fig. 4-3

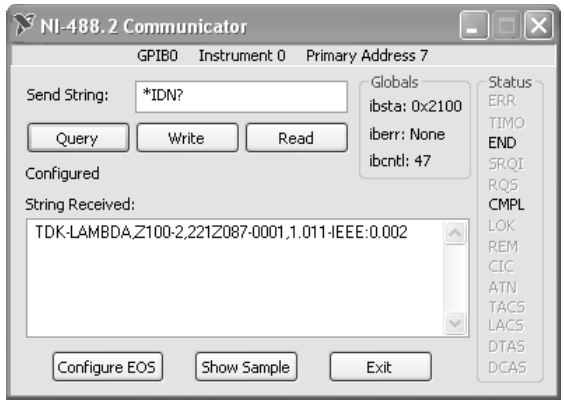

Fig.5-3: ID String Query

5. In the Send String box, *IDN? appears. Click Query. The ID string indicates the model, serial number, firmware version and the GPIB card firmware version. This will be shown in the text box below String Received. Refer to Fig.4-3.

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